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Nanotechnology: Diagnosis of Plant Diseases

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Opinion

Agriculture plays a key role for economic development in many of the states of our country. Agriculture has always been the backbone of most of the developing countries. It does not only fill the people abdomen but also fuel the economy. Food security has always been the biggest concern of the mankind. Nations, communities and Governments have been struggling with the issue since long.

The future looks even bleaker with food shortage issue looming large. The challenge is how to feed the growing population by producing more on a stagnant or shrinking landscape; with lesser input costs and with lesser hazards to the eco-system. The current global population is nearly 6 billion with 50% living in Asia.

A large proportion of those living in developing countries face daily food shortages as a result of environmental impacts or political instability, while in the developed world there is a food surplus. For developing countries the drive is to develop drought and pest resistant crops, which also maximize yield. Nanotechnology has emerged as one of the most innovative scientific field in agriculture.

"Nano" means one-billionth, thus nanotechnology deals with materials measured in a billionth of a meter. A nanometer is 1/80,000 the diameter of a human hair or approximately ten hydrogen atoms wide. Nanotechnology is the science of very small things. But nanotechnology is not just involved with small things.

Nanotechnology is a multi-disciplinary science. It includes knowledge from biology, chemistry, physics and other disciplines. Joseph and Morrison, (2006) defined Nano technology as the manipulation or self-assembly of individual atoms, molecules or molecular clusters into structures to create materials devices with new or vastly different properties.

Use of nanotechnology in agriculture can revolutionize the sector with new tools for rapid disease detection, targeted treatment, enhancing the ability of plants to absorb nutrients, fight diseases and withstand environmental pressures and effective systems for processing etc. Smart sensors and smart delivery systems will help the agricultural industry combat viruses and other crop pathogens.

By taking advantage of quantum-level properties, nanotechnology allows for unprecedented control of the material world, at the nanoscale, providing the means by which systems and materials can be built with exact specifications and characteristics, allowing materials to be lighter, stronger, smarter, cheaper, cleaner and more precise. Nanotechnology has the potential to advance agricultural productivity through genetic improvement of plants, delivery of genes and drug molecules to specific sites at cellular levels, and nanoarray based gene technologies for gene expressions in plants under stress conditions.

Early and efficient diagnosis of disease is vital for proper diseases control and management to minimize crop loss. Nanoparticles such as gold nanoparticles, magnetic nanoparticles and quantum dots, are most widely used for molecular detection purpose. Gold nanoparticles are widely used in rapid immune diagnosis, due to their unique physiochemical properties, including small-sized effect, surface effect and catalytic effect, and can also react with nucleic acid through an Au-S covalent bond and show high application value in DNA identification and detection.

Nano-phytopathology is a cutting-edge science which uses nanotechnology for detecting, diagnosing and controlling plant disease and their pathogens at an early stage, owing to crop protection from epidemic diseases. The modern plant pathologist

strives to apply his knowledge in nano phytopathology to enable understanding of controlling factors of plant diseases and to develop and/or evaluate eco-friendly diagnostic measurements. Modern nano molecular techniques are used for monitoring or understanding of pathogen population genetics, plant microbe interactions and gene transfer between pathogens and even the host. Furthermore, nanoparticles such as nano sized silica-silver have recently been applied as antimicrobial and antifungal agents. Additionally, nanomaterials scan be used for mycotoxin detection and detoxication, increasing plant resistance, plant disease forecasting and nano-molecular diagnostics of plant pathogens.

The bio-barcode assay is an ultrasensitive method of amplification and detection of proteins or nucleic acids. DNA bio-bar coded tests employ oligo nucleotide-modified magnetic gold nanoparticles (AuMNPs) for signal amplification and for simple separation of a target protein from the sample. The large b-DNA-to-recognition agent ratio affords a means of substantial signal amplification.

It is also promising by allowing the quick detection of numerous protein targets at low-attomolar concentrations [1] and nucleic acids at high-zeptomolar levels under optimized conditions [2]. The concept of the bio-barcode assay is unique and represents a potential alternative to the PCR technique. The current review deals with the application of nanotechnology for quicker, more cost-effective and precise diagnostic procedures of plant diseases.

This technology will have major impact on Indian Agriculture in coming years. Controlled use of the technology will open opportunities for developing new materials and methods that will enhance our ability to develop faster, more reliable and more sensitive analytical systems [3].

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